RESEARCH HIGHLIGHTS

Technical Series 00-147

INVESTIGATION OF BLACK SOOT STAINING IN HOUSES

Introduction

Indoor air quality investigators are often asked to investigate streaking, staining or sooting problems in houses. Such stains or streaks are usually characterized as:

- black marks on light coloured carpets along baseboards at either exterior or interior walls, at doorways and behind furniture;
- black smudges on window frames, cabinets and plastic furnishings; and sometimes
- shadowing of studs on exterior wall drywall.

These problems seem to be more prevalent in new homes but older homes are also affected. Most building scientists agree that the source of the black material causing the stains is most often carbon soot from a combustion source. Potential combustion sources in houses include furnaces, fireplaces, water heaters, gas dryers, gas ranges, smoking, vehicle exhaust from attached garages, and candle burning.

Although homeowners are often sceptical of candle burning being a prominent source of soot, literature on the topic suggests it is the likely culprit in many cases.

Research Program

This study was designed to investigate sooting problems in houses where occupants reported regular burning of candles. Samples of stained carpets, filters and other materials as well as swab samples of black dust or soot were taken from five homes. The houses that were selected for the study were all built within the last three years and occupied by persons who regularly burn candles. To examine if candle burning was a source of the soot, samples of commonly burned candles in the homes were burned in the laboratory. Other potential pollutant sources were also identified by air quality audits conducted on each home. In addition, the study included a search of industry information to uncover best practices for cost-effective clean up and control of soot or staining problems.

In the following table, the soot description and candle burning patterns are detailed for each of the five houses. Potential combustion sources and other dust sources are also described.

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Table 1: Soot Description and Candle Burning Patterns

House Number	Soot Description	Potential Combustion Sources	Other Dust Sources	Candle Burning
1	• Dark carpet streaking • Dark dust on return grilles and appliances • Gray dust on bathroom fan grille	• smoking occupants • Power vented (PV) water heater • candles	• small dog • storage of clothes • busy highway • many carpets • lots of air leakage	1 jar candle is burned every 1 to 2 weeks.
2	• Black carpet streaking • Black dust on lights, windows, inside cupboards, plastic surfaces	• Direct vented (DV) gas furnace • PV water heater • candles	• large dog • many carpets • new construction area	2 large 3-wick candles are burned 1 to 2 times a week for 2 to 3 hours.
3	• Black smudges on window frames and plastics • Stained carpet edges • Gray dust on filter pads • Black film on kitchen counter top and cabinets	• DV gas furnace • PV water heater self cleaning gas range • DV gas fireplace • candles	• many carpets • old standard vacuum cleaner	Many types of candles are burned most evenings for short periods.
4	• Dark & oily carpet streaking • Black smudges by exterior walls • Gray dust on cabinets, furnace fan and water tank	• DV gas furnace • PV water heater • candles	• 2 cats and 1 small dog • basement renovation • old & inefficient vacuum lots of air leakage	2 scented votives are burned about 1 to 2 times a week for 2 to 3 hours.
5	• Black smudges on plastics • Carpet streaking • Black smudges on windows & frames • Pleated filters are very black	• DV gas furnace • PV water heater • DV gas fireplace • candles	• 2 large fluffy cats • new construction area • many carpets	2 pillar scented candles are burned about 2 nights a week for 1 to 2 hours.

Research Findings

While the laboratory was successfully able to identify materials consistent with candle soot or residue using standard microscopic investigations, they were unable to establish a link between stained material in the homes with the soot from candles burned in those homes. Samples from house numbers 2, 3 and 5 were identified as having significant quantities of candle soot. Yet, in house numbers 1 and 4, where candle soot was not identified, the most common element in the samples was drywall compound or texture coat dust.

The soot particles in the three houses where candle soot was identified were found on window frames, inside cabinets, on light fixtures in addition to carpet streaking. In the other two houses, the streaking was limited to carpets, furnace grilles and filters.

The research shows that dust from various sources will often show up on carpets and other surfaces. It appears that candle soot can add colour and resistance to cleaning even if there is not a large quantity of the candle soot in the mixture. It may be that certain candles create the condition where normal, cleanable dust becomes more obvious and harder to remove.

Clean up of streaking problems, specifically on carpets, is difficult and rarely completely successful. Given this poor success rate, avoidance and control of contributing factors should be the focus of homeowners and builders. Recommendations included in the study should reduce the risk of streaking and sooting.

Homeowners should:

- avoid or restrict the use of candles in houses;
- use candles with properly trimmed wicks, in properly ventilated conditions as per manufacturer's instructions (The National Candle Association website gives specific information on how to choose and burn candles so as to avoid soot problems);
- avoid or limit scented candles;
- have combustion appliances in the home checked regularly for proper operation and venting effectiveness;
- keep a clean house generally and vacuum carpets regularly with an effective vacuum—central vacuums vented outside or HEPA grade filters are the best options. Use perimeter tool for wall edges;
- never idle vehicles in an attached garage and ensure the garage is properly air sealed from the house;
- eliminate or control other dust sources—properly clean up renovation projects, reduce storage of wood, paper and fabric products, control access of pets to certain areas of the house;
- purchase and maintain better filters for the forced air system.

Builders should:

- build tighter houses and specifically ensure air leakage pathways at floor header assemblies are well sealed;
- use insulation techniques and wall details that minimize thermal bridging and cold spots;
- ensure garages are air sealed from the home and any ductwork running through the garage is tightly sealed;
- ensure all combustion appliances are properly installed and vented. Avoid standing pilot appliances and encourage direct vent, sealed combustion appliances;
- clean houses thoroughly after the drywall and taping stage to eliminate drywall and other construction dust;
- ensure forced air ducts are sealed during construction and/or cleaned thoroughly before carpets and other flooring are installed;
- offer upgraded filters for forced air systems; and
- offer darker carpet colours or inform homeowners that streaking problems are more visible with light carpets.

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